Continuation-in-Part Patent Application Based on:

Docket No:	82,414A
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TOUCH SCREEN DISPLAY AND METHOD OF MANUFACTURE

Commissioner for Patents
Attn: Box Patent Application
Washington, DC 20231

Express Mail Label No: EL656969335US
Date: July 23, 2001

TOUCH SCREEN DISPLAY AND METHOD OF MANUFACTURE

Cross Reference to Related Applications

This is a continuation-in-part of US Patent Application Serial No. 09/826,194 filed April 4, 2001, entitled "Organic Electroluminescent Display with Integrated Touch Screen" by Siwinski et al.

FIELD OF THE INVENTION

This invention relates generally to a flat panel display and, more particularly, to a flat panel display with a touch screen.

BACKGROUND OF THE INVENTION

Modern electronic devices provide an increasing amount of functionality with a decreasing size. By continually integrating more and more capabilities within electronic devices, costs are reduced and reliability increased. Touch screens are frequently used in combination with conventional soft displays such as cathode ray tubes (CRTs), liquid crystal displays (LCDs), plasma displays and electroluminescent displays. The touch screens are manufactured as separate devices and mechanically mated to the viewing surfaces of the displays.

Fig. 1 shows a prior art touch screen **10**. The touch screen **10** includes a transparent substrate **12**. This substrate **12** is typically rigid, and is usually glass, although sometimes a flexible material, such as plastic, is used. Various additional layers of materials forming touch sensitive elements **14** of the touch screen **10** are formed on top of the substrate **12**. The touch sensitive elements **14** include transducers and circuitry that are necessary to detect a touch by an object, in a manner that can be used to compute the location of such a touch. A cable **16** is attached to the circuitry so that various signals may be brought onto or off of the touch screen **10**. The cable **16** is connected to an external controller **18**. The external controller **18** coordinates the application of various signals to the touch screen **10**, and performs calculations based on

responses of the touch sensitive elements to touches, in order to extract the (X, Y) coordinates of the touch.

There are three commonly used touch screen technologies that utilize this basic structure: resistive, capacitive, and surface acoustic wave (SAW). For more information on these technologies, see "Weighing in on touch technology," by Scott Smith, published in Control Solutions Magazine, May 2000.

There are three types of resistive touch screens, 4-wire, 5-wire, and 8-wire. The three types share similar structures. Fig. 2a shows a top view of a resistive touch screen **10**. Fig. 2b shows a side view of the resistive touch screen **10**. The touch sensitive elements **14** of the resistive touch screen **10** includes a lower circuit layer **20**; a flexible spacer layer **22** containing a matrix of spacer dots **24**; a flexible upper circuit layer **26**; and a flexible top protective layer **28**. All of these layers are transparent. The lower circuit layer **20** often comprises conductive materials deposited on the substrate **12**, forming a circuit pattern.

The main difference between 4-wire, 5-wire, and 8-wire touch screens is the circuit pattern in the lower circuit layer **20** and the upper circuit layer **26**, and the means for making resistance measurements. An external controller **18** is connected to the touch screen circuitry via cable **16**. Conductors in cable **16** are connected to the circuitry within the lower circuit layer **20** and the upper circuit layer **26**. The external controller **18** coordinates the application of voltages to the touch screen circuit elements. When a resistive touch screen is pressed, the pressing object, whether a finger, a stylus, or some other object, deforms the top protective layer **28**, the upper circuit layer **26**, and the spacer layer **22**, forming a conductive path at the point of the touch between the lower circuit layer **20** and the upper circuit layer **26**. A voltage is formed in proportion to the relative resistances in the circuit at the point of touch, and is measured by the external controller **18** connected to the other end of the cable **16**. The controller **18** then computes the (X, Y) coordinates of the point of touch. For more information on the operation of resistive touch screens, see "Touch Screen

Controller Tips," Application Bulletin AB-158, Burr-Brown, Inc. (Tucson, Arizona), April 2000, pages 1-9.

Fig. 3a shows a top view of a capacitive sensing touch screen **10**. Fig. 3b shows a side view of the capacitive sensing touch screen **10**. The touch sensitive elements **14** include a transparent metal oxide layer **30** formed on substrate **12**. Metal contacts **32**, **34**, **36**, and **38** are located on the metal oxide layer **30** at the corners of the touch screen **10**. These metal contacts are connected by circuitry **31** to conductors in cable **16**. An external controller **18** causes voltages to be applied to the metal contacts **32**, **34**, **36**, and **38**, creating a uniform electric field across the surface of the substrate **12**, propagated through the transparent metal oxide layer **30**. When a finger or other conductive object touches the touch screen, it capacitively couples with the screen causing a minute amount of current to flow to the point of contact, where the current flow from each corner contact is proportional to the distance from the corner to the point of contact. The controller **18** measures the current flow proportions and computes the (X, Y) coordinates of the point of touch. US Patent 5,650,597, issued July 22, 1997 to Redmayne describes a variation on capacitive touch screen technology utilizing a technique called differential sensing.

Fig. 4a shows a top view of a prior art surface acoustic wave (SAW) touch screen **10**. Fig 4b shows a side view of a SAW touch screen **10**. The touch sensitive elements **14** include an arrangement of acoustic transducers **46** and sound wave reflectors **48** formed on the face of substrate **12**. The sound wave reflectors **48** are capable of reflecting high frequency sound waves that are transmitted along the substrate surface, and are placed in patterns conducive to proper wave reflection. Four acoustic transducers **46** are formed on the substrate **12** and are used to launch and sense sound waves on the substrate surface. A cable **16** is bonded to the substrate **12**, and contains conductors that connect the acoustic transducers **46** to an external controller **18**. This external controller **18** applies signals to the acoustic transducers **46**, causing high frequency sound waves to be emitted across the substrate **12**. When an object touches the touch

screen, the sound wave field is disturbed. The transducers **46** detect this disturbance, and external controller **18** uses this information to calculate the (X, Y) coordinate of the touch.

Fig. 5 shows a typical prior art electroluminescent display such as an organic light emitting diode OLED flat panel display **49** of the type shown in US Patent 5,688,551, issued November 18, 1997 to Littman et al. The OLED display includes substrate **50** that provides a mechanical support for the display device. The substrate **50** is typically glass, but other materials, such as plastic, may be used. Light-emitting elements **52** include conductors **54**, a hole injection layer **56**, an organic light emitter **58**, an electron transport layer **60** and a metal cathode layer **62.** When a voltage is applied by a voltage source **64** across the light emitting elements **52**, via cable **67**, light **66** is emitted through the substrate **50**, or through a transparent cathode layer **62**.

The OLED structure described in relation to Fig. 5 is commonly known as a bottom-emitting structure, where light is emitted through the substrate **50**, conductors **54**, and hole injection layer **56**. An alternative OLED structure, known as a top-emitting structure, similar to that described by International Patent WO 00/17911, issued on March 30, 2000 to Pichler, is shown in Fig. 6. Here, light emitting elements **52**, including conductors **54**, a hole injection layer **56**, an organic light emitter **58**, an electron transport layer **60** and a metal cathode layer **62**, are formed on substrate **50**. A transparent cover sheet **51** is then placed above metal cathode layer **62**, and is sealed to the substrate **50**. In the top-emitting OLED structure, light is emitted by the organic light emitter **58** through the electron transport layer **60**, the metal cathode layer **62**, and the transparent cover sheet **51**. Less light is absorbed or scattered in top-emitting OLEDs, making the device more efficient. Additionally, top-emitting OLEDs often allow for larger pixel fill factors, since the light emitted is not blocked by conductors **54**.

Conventionally, when a touch screen is used with a flat panel display, the touch screen is simply placed over the flat panel display, above the surface from which light is emitted, and the two are held together by a mechanical

mounting means such as a frame. Fig. 7 shows such a prior art arrangement with a bottom-emitting touch screen mounted on an OLED flat panel display. After the touch screen and the OLED display are assembled, the two substrates **12** and **50** are placed together in a frame **68**. Sometimes, a narrow air gap is added between the substrates **12** and **50** by inserting a spacer **72** to prevent Newton rings. The thickness and materials in the substrates can degrade the quality of the image. When light passes from the underlying flat panel display through the touch screen, a change in refractive index occurs. Some light is refracted, some light is transmitted, and some light is reflected. This reduces the brightness and sharpness of the display.

Although Fig. 7 illustrates a conventional mounting means for a touch screen to a bottom-emitting OLED, the same basic method may be used for mounting a touch screen to a top-emitting OLED. Here, the touch screen's substrate **12** is placed together with the transparent cover sheet **51** (not shown) in frame **68**. A narrow air gap may be placed between the substrate **12** and the transparent cover sheet **51** by inserting spacer **72**. Light emitted by the light emitting elements **52** then passes through the transparent cover sheet **51**, through the substrate **12**, and through the touch sensitive materials **14**.

US Patent 5,982,004 issued November 9, 1999, to Sin et al. describes a thin film transistor that may be useful for flat panel display devices and mentions that touch sensors may be integrated into a display panel. However, Sin et al. do not propose a method for doing so.

US Patent 6,028,581 issued February 22, 2000, to Umeya describes a liquid crystal display with an integrated touch screen on the same face of a substrate to reduce parallax error due to the combined thickness of the liquid crystal display and the touch screen. This arrangement has the shortcoming that the existing pixel array layout must be significantly modified, incurring additional cost and reducing pixel fill factor.

US Patent 5,995,172 issued November 30, 1999, to Ikeda et al. discloses a tablet integrated LCD display apparatus wherein a touch sensitive layer is formed on the same side of a substrate as the LCD.

US Patent 5,852,487 issued December 22, 1998, to Fujimori et al. discloses a liquid crystal display having a resistive touch screen. The display includes three substrates.

US Patent 6,177,918 issued January 23, 2001, to Colgan et al. describes a display device having a capacitive touch screen and LCD integrated on the same side of a substrate.

There remains a need for an improved touch screen-flat panel display system that minimizes device weight, removes redundant materials, decreases cost, eliminates special mechanical mounting design, increases reliability, prevents Newton rings, and minimizes the degradation in image quality.

SUMMARY OF THE INVENTION

The need is met according to the present invention by providing a touch screen display that includes an electroluminescent display; a touch screen, and a transparent sheet that functions as an element of both the electroluminescent display and the touch screen

ADVANTAGES

The display according to the present invention is advantageous in that it provides a display having a minimum number of substrates, thereby providing a thin, light, easily manufacturable display.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic diagram showing the basic structure of a prior art touch screen;

Fig. 2a and 2b are schematic diagrams showing the structure of a prior art resistive touch screen;

Fig. 3a and 3b are schematic diagrams showing the structure of a prior art capacitive touch screen;

Fig. 4a and 4b are schematic diagrams showing the structure of a prior art surface acoustic wave touch screen;

Fig. 5 is a schematic diagram showing the structure of a prior art bottom-emitting organic electroluminescent display;

Fig. 6 is a schematic diagram showing the structure of a prior art top-emitting organic electroluminescent display;

Fig. 7 is a schematic diagram showing the combination of a touch screen with a flat panel electroluminescent display as would be accomplished in the prior art;

Fig. 8 is a schematic diagram showing the basic structure of a bottom-emitting electroluminescent display with a touch screen according to the present invention;

Fig. 9 is a schematic diagram showing an embodiment of the present invention including a resistive touch screen utilizing a bottom-emitting structure;

Fig. 10 is a schematic diagram showing an embodiment of the present invention with a capacitive touch screen utilizing a bottom-emitting structure;

Fig. 11 is a schematic diagram showing an embodiment of the present invention with a surface acoustic wave touch screen utilizing a bottom-emitting structure;

Fig. 12 is a schematic diagram showing the basic structure of a top-emitting electroluminescent display with a touch screen according to the present invention;

Fig. 13 is a schematic diagram showing an embodiment of the present invention including a resistive touch screen utilizing a top-emitting structure;

Fig. 14 is a schematic diagram showing an embodiment of the present invention with a capacitive touch screen utilizing a top-emitting structure; and

Fig. 15 is a schematic diagram showing an embodiment of the present invention with a surface acoustic wave touch screen utilizing a top-emitting structure.

DETAILED DESCRIPTION OF THE INVENTION

Referring to Fig. 8, a touch screen display generally designated **100** according to the present invention includes a transparent sheet **102** having light emitting elements **52** of an electroluminescent display formed on one face of the substrate for emitting light through the substrate, in a bottom-emitting structure, and touch sensitive elements **14** of a touch screen formed on the other face of the transparent sheet **102.** The transparent sheet **102** is made of a transparent material, such as glass or plastic, and is thick enough to provide mechanical support for both the light emitting elements **52** and the touch sensitive elements **14**. This improved display eliminates the need for a second substrate, and allows both the light emitting elements **52** of the image display and the touch sensitive elements **14** to be formed on the same substrate without interfering with each other. This reduces system cost, manufacturing cost, and system integration complexity. Various prior art touch screen technologies may be employed in the touch screen display **100** as described below.

Referring to Fig. 9, a touch screen display **100** including a resistive touch screen according to one embodiment of the present invention utilizing a bottom-emitting structure is shown. A lower circuit layer **20** and metal interconnections **54** are formed, for example by photolithographically patterning respective conductive layers on opposite faces of transparent sheet **102**. The conductive layers comprise for example a semitransparent metal, typically ITO. On the image display side of the transparent sheet **102**, a hole injection layer (HIL) **56** is applied to the device over the metal interconnections **54**. Then

organic light emitters **58** are deposited on top of the HIL layer **56**. During the deposition stage, the organic material is patterned for individual colors by either shadow masking or other vacuum deposition techniques. Next, an electron transport layer (ETL) **60** is deposited, followed by a metal cathode layer **62**. On the touch screen side of the transparent sheet **102**, a flexible spacer layer **22** containing a matrix of spacer dots **24** is placed on top of the lower circuit layer **20**. A flexible upper circuit layer **26** is then attached to the device over the spacer layer **22**. The stack is protected by a flexible top protective layer **28** that is laminated on top of the upper circuit layer **26**. A cable **16** is attached to the touch screen elements **14**, completing the touch screen portion of the display **100**. Finally, a cable **67** is attached to the light emitting elements **52**, resulting in a fully manufactured touch screen display **100**.

Fig. 10 shows a touch screen display **100** with a capacitive touch screen according to the present invention using a bottom-emitting structure. A transparent sheet **102** is coated on one face (the touch screen face) with a transparent metal oxide layer **30**. On the other face of the transparent sheet **102**, the light emitting elements **52** of an image display are formed. First, metal interconnections **54** are formed on the transparent sheet **102**. Next, a hole injection layer (HIL) **56** is applied to the device over the metal interconnections **54**. Then organic light emitters **58** are coated and patterned on top of the HIL layer **56**. Next, an electron transport layer (ETL) **60** is deposited, followed by a metal cathode layer **62**. Metal contacts **32, 34, 36,** and **38** are then placed at the corners of the metal oxide layer **30**, completing the touch screen elements **14**. Finally, a cable **67** is attached to the light emitting elements **52**, and a cable **16** is attached to touch screen elements **14**, where the conductors of the cable **16** are connected to the metal contacts **32, 34, 36,** and **38**, resulting in a fully manufactured touch screen display **100**.

Fig. 11 shows a bottom-emitting touch screen display **100** manufactured with a surface acoustic wave touch screen. A series of acoustic surface wave reflectors **48** are etched into one face of transparent sheet **102**.

Next, an image display **52** is formed on the opposite face of the transparent sheet **102**, started by forming metal interconnections **54**. Then, a hole injection layer (HIL) **56** is applied to the device over the metal interconnections **54**. Organic emitters **58** are then coated and patterned on top of the HIL layer **56**. Next, an electron transport layer (ETL) **60** is deposited, followed by a metal cathode layer **62**, completing the light emitting elements **52**. The touch screen elements **14** are then completed by forming four acoustic transducers **46** on the transparent sheet **102**. Finally, a cable **67** is attached to the light emitting elements **52** of the image display, and a cable **16** is attached to the touch sensitive elements **14** of the touch screen, resulting in a fully manufactured touch screen display **100**.

Fig. 12 shows the basic structure of the present invention utilizing a top-emitting structure for the electroluminescent display. A touch screen display **100** includes a substrate **104** having light emitting elements **52** of an electroluminescent display formed on one face, and a transparent sheet **102** having touch sensitive elements of a touch screen formed on one face. In this structure, light from the light emitting elements **52** passes through the transparent sheet **102**. The transparent sheet **102** is sealed to the substrate **104** along the sides of the two materials, where one face of the transparent sheet **102** is contained within the touch screen display **100**, forming a top-emitting structure. Touch sensitive elements **14** of a touch screen formed on the other face of the transparent sheet **102.** The transparent sheet **102** is made of a transparent material, such as glass or plastic, and is thick enough to provide mechanical support for the touch sensitive elements **14**. A conventional touch screen consists of touch sensitive elements **14** and a transparent material used as a substrate. In the present embodiment, the touch sensitive materials **14** may be formed on the transparent sheet **102** of the touch screen display **100**, eliminating the need for an additional material layer for the combined structure. This reduces system cost, manufacturing cost, and system integration complexity. Various prior art touch screen technologies may be employed in the display **100** as described below.

Referring to Fig. 13, a touch screen display **100** including a resistive touch screen according to one embodiment of the present invention utilizing a top-emitting structure is shown. Metal interconnections **54** are formed, for example by photolithographically patterning respective conductive layers on one face of substrate **104**. A hole injection layer (HIL) **56** is applied to the device over the metal interconnections **54**. Then organic light emitters **58** are deposited on top of the HIL layer **56**. During the deposition stage, the organic material is patterned for individual colors by either shadow masking or other vacuum deposition techniques. Next, an electron transport layer (ETL) **60** is deposited, followed by a semi-transparent or transparent metal cathode layer **62**. Transparent sheet **102** is then sealed to the substrate **104**. A lower circuit layer **20** is formed on the face of the transparent sheet **102.** Next, a flexible spacer layer **22** containing a matrix of spacer dots **24** is placed on top of the lower circuit layer **20**. A flexible upper circuit layer **26** is then attached to the device over the spacer layer **22**. The stack is protected by a flexible top protective layer **28** that is laminated on top of the upper circuit layer **26**. A cable **16** is attached to the touch screen elements **14**, completing the touch screen portion of the touch screen display **100**. Finally, a cable **67** is attached to the light emitting elements **52**, resulting in a fully manufactured touch screen display **100**. This method for producing an integrated touch screen-electroluminescent display device utilizes one sequential manufacturing process, reducing overall time and materials flow problems, and allows for encapsulation of the light emitting elements as quickly as possible, improving yields.

Alternatively, the touch screen display of Fig. 13 may be manufactured in a second manner, where the touch sensitive elements are placed on the transparent sheet **102** prior to encapsulation. In such a process, metal interconnections **54** are formed, for example by photolithographically patterning respective conductive layers on one face of substrate **104**. A hole injection layer (HIL) **56** is applied to the device over the metal interconnections **54**. Then organic light emitters **58** are deposited on top of the HIL layer **56**. During the

deposition stage, the organic material is patterned for individual colors by either shadow masking or other vacuum deposition techniques. Next, an electron transport layer (ETL) **60** is deposited, followed by a semi-transparent or transparent metal cathode layer **62**. In another location, typically prior to or simultaneous with the above manufacturing steps, the touch sensitive elements **14** are formed on one face of transparent sheet **102**. First, a lower circuit layer **20** is formed on the face of the transparent sheet **102.** Next, a flexible spacer layer **22** containing a matrix of spacer dots **24** is placed on top of the lower circuit layer **20**. A flexible upper circuit layer **26** is then attached to the device over the spacer layer **22**. The stack is protected by a flexible top protective layer **28** that is laminated on top of the upper circuit layer **26**.

At this point, the substrate **104**, the transparent sheet **102**, and the materials attached to them, are brought to a common location. The transparent sheet **102** is sealed to the substrate **104**, where the light emitting elements **52** are placed between the substrate **104** and the transparent sheet **102**, while the face with the touch sensitive elements **14** is placed away from the substrate **104**. The touch screen display **100** is now encapsulated. Next, a cable **16** is attached to the touch screen elements **14**, completing the touch screen portion of the touch screen display **100**. Finally, a cable **67** is attached to the light emitting elements **52**, resulting in a fully manufactured touch screen display **100**. This method for producing an integrated touch screen-electroluminescent display device decouples the manufacturing of the touch sensitive elements **14** from the light emitting elements **52**. Each structure may then be tested separately, and a defective structure may then be discarded, prior to encapsulation. This improves overall yield, since one defective structure does not require both structures to be discarded.

Fig. 14 shows a touch screen display **100** with a capacitive touch screen according to the present invention using a top-emitting structure. According to one method of manufacturing, light emitting elements **52** of an image display are formed on one face of substrate **104**. First, metal

interconnections **54** are formed on the substrate **104**. Next, a hole injection layer (HIL) **56** is applied to the device over the metal interconnections **54**. Then organic light emitters **58** are coated and patterned on top of the HIL layer **56**. Next, an electron transport layer (ETL) **60** is deposited, followed by a semi-transparent or transparent metal cathode layer **62**. Transparent sheet **102** is then sealed to substrate **104**, encapsulating the display. Next, a transparent metal oxide layer **30** is coated on the top transparent material. Metal contacts **34,** and **38** are then placed at the corners of the metal oxide layer **30**, completing the touch screen elements **14**. Finally, a cable **67** is attached to the light emitting elements **52**, and a cable **16** is attached to touch screen elements **14**, where the conductors of the cable **16** are connected to the metal contacts **34,** and **38**, resulting in a fully manufactured touch screen display **100**.

Alternatively, the touch screen display of Fig. 14 may be manufactured in a second manner, where the touch sensitive elements are placed on the transparent sheet **102** prior to encapsulation. In such a process, metal interconnections **54** are formed on one face of the substrate **104**. Next, a hole injection layer (HIL) **56** is applied to the device over the metal interconnections **54**. Then organic light emitters **58** are coated and patterned on top of the HIL layer **56**. Next, an electron transport layer (ETL) **60** is deposited, followed by a semi-transparent or transparent metal cathode layer **62**. In another location, typically prior to or simultaneous with the above manufacturing steps, the touch sensitive elements **14** are formed on one face of transparent sheet **102**. First, a transparent metal oxide layer **30** is coated on the top transparent material. Metal contacts **34,** and **38** are then placed at the corners of the metal oxide layer **30**, completing the touch screen elements **14**.

At this point, the substrate **104**, the transparent sheet **102**, and the materials attached to them, are brought to a common location. The transparent sheet **102** is sealed to the substrate **104**, where the light emitting elements **52** are placed between the substrate **104** and the transparent sheet **102**, while the face with the touch sensitive elements **14** is placed away from the substrate **104**. The

touch screen display **100** is now encapsulated. Transparent sheet **102** is then sealed to substrate **104**, encapsulating the touch screen display. Finally, a cable **67** is attached to the light emitting elements **52**, and a cable **16** is attached to touch screen elements **14**, where the conductors of the cable **16** are connected to the metal contacts **34,** and **38**, resulting in a fully manufactured touch screen display **100**.

Fig. 15 shows a top-emitting display **100** manufactured with a surface acoustic wave touch screen. According to one method of manufacturing, an image display **52** is formed on the opposite face of the substrate **104**, started by forming metal interconnections **54**. Then, a hole injection layer (HIL) **56** is applied to the device over the metal interconnections **54**. Organic emitters **58** are then coated and patterned on top of the HIL layer **56**. Next, an electron transport layer (ETL) **60** is deposited, followed by a semi-transparent or transparent metal cathode layer **62**, completing the light emitting elements **52**. After the deposition of the semi-transparent or transparent metal cathode layer **62**, transparent sheet **102** is then sealed to substrate **104**, encapsulating the touch screen display. Next, a series of acoustic surface wave reflectors **48** are etched into exposed face of transparent sheet **102**. The touch screen elements **14** are then completed by forming four acoustic transducers **46** on the transparent sheet **102**. Finally, a cable **67** is attached to the light emitting elements **52** of the image display, and a cable **16** is attached to the touch sensitive elements **14** of the touch screen, resulting in a fully manufactured touch screen display **100**.

Alternatively, the organic electroluminescent display of Fig. 15 may be manufactured in a second manner, where the touch sensitive elements are placed on the transparent sheet **102** prior to encapsulation. In such a process, an image display **52** is formed on the opposite face of the substrate **104**, started by forming metal interconnections **54**. Then, a hole injection layer (HIL) **56** is applied to the device over the metal interconnections **54**. Organic emitters **58** are then coated and patterned on top of the HIL layer **56**. Next, an electron transport layer (ETL) **60** is deposited, followed by a semi-transparent or transparent metal

cathode layer **62**, completing the light emitting elements **52**. Elsewhere, and typically prior to the above manufacturing steps, a series of acoustic surface wave reflectors **48** are etched into one face of transparent sheet **102**. The touch screen elements **14** are then completed by forming four acoustic transducers **46** on the transparent sheet **102.** After the deposition of the semi-transparent or transparent metal cathode layer **62,** the transparent sheet **102** is then sealed to substrate **104,** encapsulating the touch screen display. Note that the face of the transparent sheet containing the touch sensitive elements is placed away from the substrate **104**. Finally, a cable **67** is attached to the light emitting elements **52** of the display, and a cable **16** is attached to the touch sensitive elements **14** of the touch screen, resulting in a fully manufactured touch screen display **100**.

The invention has been described in detail with particular reference to certain preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention. For example, US Patent 5,703,436 issued on December 30, 1997, to Forrest et al. describes an OLED that can simultaneously emit light via both top-emitting and bottom-emitting mechanisms. Such a display can utilize the current invention by forming touch sensitive elements of a touch screen on either face, or both faces, of the OLED device, using the methods described herein. Such an integrated touch screen-OLED device falls under the scope of this invention. Additionally, US Patent 5,834,893 issued on November 10, 1998, to Bulovic et al. describes an inverted OLED structure, in which a metal cathode is formed on the substrate and an anode is formed above the organic light emitting materials. Such an OLED structure can utilize the current invention by forming touch sensitive elements of a touch screen on either face of the OLED device, using the methods described herein. Such an integrated touch screen-OLED device falls under the scope of this invention.

Finally, it is understood that certain manufacturing process steps may be reordered, deleted, or inserted, based on the needs for a particular touch screen display device and for a particular method of fabrication. All such

modifications that utilize the basic teachings disclosed here are within the spirit and scope of the present invention.

PARTS LIST

10	touch screen
12	substrate
14	touch sensitive elements
16	cable
18	controller
20	lower circuit layer
22	flexible spacer layer
24	spacer dot
26	flexible upper circuit layer
28	flexible top protective layer
30	metal oxide layer
31	circuitry
32	metal contact
34	metal contact
36	metal contact
38	metal contact
46	acoustic transducer
48	acoustic surface wave reflector
49	OLED flat panel display
50	substrate
51	cover sheet
52	light emitting elements
54	conductors
56	hole injection layer
58	organic light emitters
60	electron transport layer
62	cathode layer
64	voltage source
66	light
67	cable
68	frame
72	spacer
100	touch screen display
102	transparent sheet
104	substrate